USDA-ARS / USWBSI
FY03 Final Performance Report (approx. May 03 – April 04)
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Cover Page

PI:	**Gregory Shaner**
Institution:	**Purdue University**
Address:	**Department of Botany and Plant Pathology** **1155 Lilly Hall** **West Lafayette, IN 47907-1155**
E-mail:	**shaner@purdue.edu**
Phone:	**765-494-4651**
Fax:	**765-494-0363**
Year:	**FY2003 (approx. May 03 – April 04)**
FY03 ARS Agreement ID:	**59-0790-9-065**
FY03 ARS Agreement Title:	**Fusarium head blight of wheat: epidemiology, and management by genetic and chemical means.**
FY03 ARS Award Amount:	**$ 95,279**

USWBSI Individual Project(s)

USWBSI Research Area*	Project Title	ARS Adjusted Award Amount
CBC	Uniform Trials for Control of Fusarium Head Blight.	$ 11,892
EDM	Effect of inoculum density and weather on Fusarium head blight of wheat.	$ 40,460
GIE	Characterization of New Sources of Resistance to Fusarium Head Blight of Wheat.	$ 42,927
	Total Amount Recommended	**$95,279**

Principal Investigator Date

* BIO – Biotechnology
CBC – Chemical & Biological Control
EDM – Epidemiology & Disease Management
FSTU – Food Safety, Toxicology, & Utilization
GIE – Germplasm Introduction & Enhancement
VDUN – Variety Development & Uniform Nurseries

(Form – FPR03)

Project 1: ***Uniform Trials for Control of Fusarium Head Blight.***

1. What major problem or issue is being resolved and how are you resolving it?

Scab has become a serious disease of wheat and barley in many areas of the US. Effective control will likely require a combination of disease management strategies, including use of fungicides. This project is part of a uniform fungicide evaluation project, in which the same treatments are applied at several locations in the U.S.

2. What were the most significant accomplishments?

Fungicide trials were conducted at 2 locations in Indiana during 2003: at the Purdue Agronomy Center for Research and Education (ACRE) near West Lafayette and at the Southeast Purdue Agricultural Center (SEPAC), near North Vernon. A high incidence and severity of FHB developed at ACRE under mist irrigation. All fungicide treatments, even those applied at the boot stage, reduced incidence of head blight. Only the JAU6476 and V-10116 treatments applied during flowering reduced severity of blight (severity is the proportion of the head blighted, for those heads that show any blight symptom). Most treatments reduced the number of *Fusarium* damaged kernels. Several treatments applied at flowering reduced DON concentration in grain. Three treatments increased yield significantly. Test weights were low in all treatments and were not improved by any treatment, probably the result of severe lodging. At SEPAC, all treatments reduced FHB incidence, but as at ACRE, JAU6476 and V-10116 were most effective. By the time of the second assessment, incidence and severity had increased in all treatments, but there was still less blight in several treatments than in the unsprayed control. The incidence of *Fusarium*-damaged kernels and concentrations of DON in grain were quite high, but 2 treatments (JAU6476 and V-10116) reduced DON by more than 39%. Folicur did not reduce DON at either location.

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Project 2: ***Effect of inoculum density and weather on Fusarium head blight of wheat.***

1. What major problem or issue is being resolved and how are you resolving it?
Effective management of scab requires a thorough understanding of the relation between weather and inoculum production, inoculum dispersal, and disease development. This information is necessary to develop disease forecasts, which can be used to assess risk of scab in various regions, for making decisions about whether and when to use fungicides, and for decisions about marketing and utilizing grain. Also, understanding the conditions that favor scab will permit creation of epidemics in the field that are essential for effective selection for resistance, for evaluation of experimental fungicides, or evaluation of other control measures.

2. What were the most significant accomplishments?
We sampled spores of *Gibberella zeae* in wheat plots with different amounts of corn residue on the soil surface with the Burkard volumetric samplers. There was a peak in spores captured between 8 and 15 May, before wheat flowered, and again after flowering was over. Spores were detected nearly every day from 6 May to 16 June. Numbers of spores per day fluctuated in a fairly consistent pattern: 2 days with high numbers, followed by 1 day with low numbers. Over the total sampling period, spores were more abundant in the high residue plot than in the medium and no residue plots. The number of spores recovered each day from washed wheat heads was correlated with the number captured by the Burkard samplers (r = 0.63). Head blight symptoms did not appear until late in the season. There was a substantial increase in both incidence and severity of blight between 18 and 24 June. The doubling of incidence in that short period was surprising, because by 18 June heads were presumably past the growth stage for primary infection. Possibly the cool weather during June delayed symptom development in some heads that had been infected earlier. Residue density had no effect on incidence or severity of head blight. Weather was highly favorable for head blight and probably obscured differences in local inoculum density. For the 41-d period of 6 May through 16 June, temperatures were nearly always in a favorable range for disease (9 to 30 °C), rain fell on 19 d, and relative humidity was >90% for an average of 8 h d^{-1}.

We rated entries in state variety trials at 4 research farms. Head blight was severe at 2 southern Indiana sites, moderate at another site, present only on one very susceptible cultivar at the fourth. For the 3 sites where head blight could be rated, there was a low correlation between FHB index and frequency of *Fusarium*-damaged kernels (FDK) or DON. When the FHB index was above16%, there were no low values of FDK or DON, but for lower FHB indexes there was a wide range of FDK and DON. For samples over the full range of FHB index values some DON levels were greater than 5 ppm. Correlation between FDK and DON was moderately high (r = 0.88). Some apparently sound kernels in every sample were infected by *F. graminearum*, at frequencies of 5 to 69%. The correlation between asymptomatic infection and FDK was 0.76. The correlation between DON and asymptomatic infection was 0.71. The correlation between DON and total kernel infection was 0.72. Even though all of these correlations were significant, there was a considerable scatter of points, and the use of regression to predict kernel contamination or DON content from FHB index or FDK would not be reliable. Even for the relation between DON and FDK, which had the strongest correlation, there was a considerable range in DON levels over the range of 3% to 15% FDK. Only when FDK was 1% or less was DON always below 2 ppm.

Project 3: ***Characterization of New Sources of Resistance to Fusarium Head Blight of Wheat.***

1. What major problem or issue is being resolved and how are you resolving it?

Resistant cultivars will be an important component of an integrated disease management strategy for FHB. Genes for resistance in addition to those in Sumai 3 need to be identified, to achieve a greater degree of resistance and to diversity resistance in areas regularly prone to the disease. We are identifying and characterizing new sources of resistance, phenotypically and genetically, and developing techniques to test for type I resistance.

2. What were the most significant accomplishments?

We evaluated type I resistance in a group of lines previously selected for type II resistance. In repeated experiments, we inoculated some plants by point inoculation and other plants by spray inoculation. We assessed type I resistance as the percentage of spikelets blighted 5 d after inoculation, reasoning that later evaluations would be confounded by type II resistance. We assessed type II resistance as the number of blighted spikelets 20 d after inoculation of a single, well-developed floret near the top of the head. There were highly significant differences in type II resistance among lines within each experiment, consistent with previous tests of this material. The correlation between the two experiments was high (r = 0.719). Within each spray inoculation experiment there were likewise highly significant differences among lines for type I resistance, with about a 4-fold difference in the percentage of blighted spikelets 5 d after inoculation. However, expression of type I resistance was not as repeatable as type II resistance. The correlation between the 2 experiments was only 0.44. In neither experiment was there a correlation between type I and type II resistance. A marker analysis conducted by Dr. G-H Bai revealed that most of these lines do not carry the major resistance QTL on 3BS.

To investigate the effect of inoculation variables on the expression of type I resistance, we inoculated a subset of lines from the experiment described above by spraying them with either 20,000 or 40,000 spores/ml, on one or both sides of the head, at either early flowering (GS 10.52) or full flowering (GS 10.54). In repeated experiments the effect of each variable was highly significant. There were also significant interactions between line and each of the inoculation variables, indicating that the degree of type I shown by a line, relative to other lines, depended on the conditions of the test. Based on preliminary analysis of the experiments, it appears that an inoculum concentration of 20,000 spores/ml, applied at full flowering, to both sides of the head may be the more reliable means to evaluate type I resistance.

We also compared type I with type II resistance in a recombinant inbred population derived from Clark (susceptible) x Chokwang (moderately resistant). The population was tested twice for type II resistance and 3 times for type I resistance. Family means for type II resistance ranged from 3 blighted spikelets to all spikelets blighted. The correlation between the repeated type II tests was 0.509. Among the 3 evaluations of type I resistance, line means ranged from 3% to 58, 86, or 50% of the spikelets blighted. The inoculum concentration for the first and second tests was 40,000 spores/ml; that for the third test was 20,000 spores/ml. As found in the experiments reported above, the correlations of type I resistance between experiments were low. There was no correlation between type I and type II resistance in this population. Three RILs consistently showed a high degree of type I resistance, but none of these had a high level of type II resistance. Chokwang has a minor gene for resistance at 3BS, but more of its resistance appears to be at a locus on 5D, based on marker analysis conducted by Dr. Bai.

Include below a list of the publications, presentations, peer-reviewed articles, and non-peer reviewed articles written about your work that resulted from all of the projects included in you grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

1. Shaner G, Buechley G. 2004. Control of wheat diseases in Indiana with foliar fungicides, 2003. F&N Tests 59:CF012. Available at http://www.apsnet.org/online/FNtests/vol59
2. Buechley G, Shaner G. 2003. Control of Fusarium head blight with fungicides in Indiana, 2003. 2003 National Fusarium Head Blight Forum Proceedings. Available online at http://www.scabusa.org/forum.html#forum03
3. Shaner G, Buechley. 2003 Relation between head blight and grain quality in the Indiana FHB epidemic of 2003. 2003 National Fusarium Head Blight Forum Proceedings. Available online at http://www.scabusa.org/forum.html#forum03
4. Shaner G, Buechley. 2003 Relation between type II and type I resistance to Fusarium graminearum in wheat. 2003 National Fusarium Head Blight Forum Proceedings. Available online at http://www.scabusa.org/forum.html#forum03